Observing System Research Studies

D.E.Harrison
NOAA/Pacific Marine Environmental Laboratory, Seattle, WA

1. Project Summary:

This project supports the design, development and evolution of the global ocean observing system for climate. An effective observing system must be built around what is known about the space and time scales and uncertainties of the climate signals of interest, relative to the background oceanic variability. Design and development results are accomplished through a variety of data analysis and modeling studies intended to expand our knowledge about what we know and what we cannot know from the observing system as deployed and the historical data set that has been produced over the decades. The evolution of the observing system is guided through studies of alternative observing strategies and evaluation of the differences between available ocean analysis products (taken as one measure of the uncertainty in these products). Some studies also have been carried out to establish the societal relevance of indices based on accurate, sustained global ocean observations and analyses of these observations.

Finally the Office of Climate Observations and NOAA's ocean and climate observing goals are supported through the PI's activities as Chair of the intergovernmental Ocean Observations Panel for Climate (co-sponsored by the GOOS, GCOS and WCRP) and other national and international sustained ocean observing and science leadership activities. The PI also contributes to the development of international global operational oceanography as a member of the JCOMM Management Committee and work with several of its Program Areas, including the Observation Coordination Group.

No data are collected through this project, so the Ten Climate Monitoring Principles are not relevant to the activities undertaken.

Initial focus has been on SST and subsurface temperature variability since these are agreed to be very important quantities for climate impacts. This work continued during FY06 and was extended to include initial studies of the status of ocean sea ice knowledge. During FY06 significant progress was made on studies based of historical ocean subsurface temperature data base.

2. FY06 Progress:

Summary and Overview

Overall, the work of the group provided a variety of scientific and social impact justifications for continuing the deployment of the planned global climate observing system. Progress continued to be made on defining the space and time scales of observations needed for specific phenomena that must be accurately observed. Some progress also was made on the development of an initial set of ocean climate indices. The Ocean Observations Panel for Climate web site was modified to provide near-real time access to a variety of relevant ocean climate indices (see **http://ioc3.unesco.org/oopc/state_of_the_ocean/index.php**).

Andy Chiodi successfully defended his PhD thesis and continues to work on TMAP research as a JISAO research scientist. Mark Carson successfully defended his MS work. Sean Herring will be leaving during FY07.

The Indian ocean remained a focus of activity, because NOAA plans to continue to extend the tropical mooring array into this ocean in FY07. Indian continental rainfall and its dependence on SST anomalies is one of the primary societal impacts, as almost one billion people depend on the Southwest monsoon's rainfall. Rainfall variability in eastern tropical Africa also is very important to the peoples of that area and work relevant to this region was completed.) Chiodi and Harrison (2007) identifies an important process that contributes to low frequency Indian SST variability relevant to east African rainfall; meridional atmospheric advection of surface water vapor is shown to be much more important than had been thought. Net surface heating due to zonal wind speed variation is not dominant, as has been suggested by other work.

Predicting the termination of El Nino events is another objective of NOAA's seasonal to interannual prediction efforts. Via a series of ocean numerical model studies, the processes responsible for the termination of the 1997-98 and 2002-03 El Nino events have been identified. In each case the mechanism appears to be that proposed by Harrison and Vecchi (1999), in which the coupled interaction between the seasonal meridional cycle of solar insolation and near-equatorial SST anomalies, and the zonal wind anomalies associated with the resulting SST anomalies near the Dateline, is key. Delayed oscillator processes are not necessary to account for the observed oceanic behavior. The state of cold tongue zonal winds at the height of the El Nino determines whether the oceanic response to the zonal wind anomalies will lead to termination of the El Nino in early Spring (as happened in 2002-03), or if the El Nino will continue into late Spring (as happened in 1997-98 and 1982-83). Again, accurate near-equatorial wind and SST knowledge, such as is obtained from the TAO/Triton array, is key to successful prediction.

Work has also continued in the use of TAO/Triton data to test existing models of the equatorial Pacific. It was found previously that the Gent/Cane intermediate model cannot be reconciled with the observations, when used with the limited vertical resolution that has been adopted so far in model studies using this formulation. A similar result was found using the somewhat more physically complex Gent-Cane “intermediate” model of the tropical ocean. The mooring data have been essential to this study, providing an important result for the relevance of intermediate coupled models for study of El Nino predictability and processes. This work has been accepted for publication.

The importance of high latitude information for US seasonal weather anomaly forecasting has been given a new twist by our discovery that the weather anomalies, particularly over the eastern half of the US and over Alaska during an El Nino winter depend strongly on the sign of the Arctic Oscillation (AO). Further we have found that there is a reasonable statistical basis for Winter AO forecasting, given knowledge of autumn AO conditions. We have communicated this result at national meetings and to L. Uccelini. Accurate knowledge of the AO thus appears key to improved US winter weather forecasts. It may be that improved knowledge of MSLP over the Arctic will lead to improved understanding of the AO and improved means for its seasonal prediction. This work has been accepted for publication.

The importance of having substantially enhanced global coverage of subsurface ocean data has been made clear by the MS thesis work of Mark Carson. In this work the historical ocean data base was examined to identify those grid boxes where there was sufficient data in time to define a statistically significant temperature trend over the period 1950-2000. It was found that even at 100m depth, much less than half the ocean has sufficient data, and was shown that, of the boxes where such data density is found, roughly half of them involve warming trends and half cooling trends. It was not sensible to attempt to estimate global ocean temperature trends. At 300m and 500m much less of the ocean had sufficient data. Runing 20-yr trends also were estimated and it was found that there is lots of decadal time scale trend variability, which makes it clear that it is unwise to extrapolate trends based only on the recent satellite data era (~20years) to longer term trends. This work establishes the importance of additional work to estimate the uncertainty in recently published global ocean temperature trends, and makes very clear the contribution that completing and sustaining the global Argo array of profiling floats will make to important matters like knowledge of subsurface ocean temperature variability and trends. A first paper on this topic has been accepted for publication.

Publications

Harrison, D.E. and A. Chiodi (2007) Westerly Wind Events and Dateline El Nino events. J. Climate (in preparation)

Harrison, D.E. and M. Carson (2007) Is the World Ocean warming, Pt. II?
(In preparation)

Chiodi, A.M., and D.E. Harrison (2007): Mechanisms of summertime subtropical Southern Indian Ocean sea surface temperature variability. J. Climate. [to appear]

Harrison, D.E. and M. Carson (2007) Is the World Ocean warming? J. Phys. Oc. (to appear, Carl Wunsch special issue)

Vecchi, G.A. and D.E. Harrison (2006). On the termination of the 1997-98 El Nino: Part I. Mechanisms of oceanic change. J. Climate (in press)

Bennett, A.F, B.S. Chua, H.-E. Ngodock, D.E.Harrison, M.J.McPhaden (2006) Generalized inversion of the Tropical Atmosphere Ocean (TAO) data and the Gent-Cane model of the tropical Pacific. J. Marine Research. 64(1), 1-42

Bond, N.A. and D.E. Harrison (2006) U.S. Winter Weather Anomalies with El Nino and negative Arctic Oscillation: 2002-03 and before. Int'l Journal of Climatology. 26(13), 1821-1841

Vecchi, G.A., and D.E. Harrison (2006): The termination of the 1997–98 El Niño. Part I: Mechanisms of oceanic change. J. Climate, 19(12), 2633–2646. [PDF Version]

Chiodi ,A. and D.E. Harrison (2006). Summertime Subtropical SST Variability. Geophys Res. Lett. 33, L08601, doi: 10.1029/2005GL024524.

Harrison, D.E. (2006): Observing system research studies. In Annual Report on The State of the Ocean and the Ocean Observing System for Climate, Annual Report, Fiscal Year 2005, J.M. Levy (ed.), NOAA/Climate Program Office/Office of Climate Observation, 281–283.

Larkin, N.K., and D.E. Harrison (2005): Global seasonal temperature and precipitation anomalies during El Niño autumn and winter. Geophys. Res. Lett., 32, L16705, doi: 10.1029/2005GL022860. [PDF Version]

Community Service positions

WCRP/GOOS/GCOS Ocean Observations Panel for Climate, Chair
OAR Climate Observing System Council, Chair
US GODAE Steering Team, Co-Chair
US GOOS SC
WCRP/GCOS Atmospheric Observation Panel for Climate
WCRP Working Group on Observations and Analysis
CLIVAR Global Synthesis and Observations Project
JCOMM Management Committee
WCRP Joint Scientific Committee
JISAO Senior Fellow
JIMAR Senior Fellow